I. MEASUREMENT OF DC AND AC VOLTAGE AND CURRENT , MEASUREMENT UNCERTAINTY AND ERRORS. MESUREMENT OF THE PARAMETERS OF DIODES AND TRANSISTORS

Theory:

Theory of errors and uncertainty in the measurement. Uncertainty of type A ,type B and C. Definitions of the instrument precision by the producers. Principle of multimeters. Measurement of DC and AC voltage and current. Connection of the multimeter to the tested circuit. Measurement of the effective value of the voltage and current- definitions & principles. Measurement of the effective value alternating voltage/current with or without superimposed direct voltage/current. Shape coefficient, crest factor. Testing of diodes and transistors using the multimeter Principle of the digital frequency measurement.

Exercises:

1) Get acquainted with Agilent 33220A waveform generator. Set the appropriate load value according to the resistor used (Utility > Output Setup> Load> 50Ω). ATTENTION: The generator output must be matched to the load impedance for all laboratory tasks.

2) Set the generator for harmonic signal output of 2Vpp amplitude and 100 Hz frequency (setting of the generator, not measured value on the voltmeter). Connect the rectifier to loaded output according to the schematic. Measure the rectified voltage by available multimeters (using DC mode). Read at least 10 measured values. Estimate measurement uncertainty of type A. Estimate the measurement uncertainty of type B based by parameters from datasheets. Determine overall uncertainty of your measurements (type).

3) Generate a harmonic, rectangular, triangular, saw tooth and at least one of embedded arbitrary signals with arbitrary amplitude from the range 1-5 V and frequency from the range 50-300 Hz with the offset equal to zero. Measure voltages for all shapes using both a TRMS voltmeter and simple multimeter with diode rectifier. Explain why the multimeter readings differ for every waveform and amplitude. Use a multimeter also for frequency measurement of every waveform.

4) Repeat task 3 for harmonic, rectangular, triangular, saw-tooth waveform with DC offset set to 1V. Measure the output voltage of the generator by TRMS voltmeter in both AC and DC mode. What is the total dissipated power on the resistor load and what is the effective value of the voltage? Hint - Parceval´s theorem.

5) Generate a harmonic signal with amplitude 1V and frequency of 5Hz. What is measured by the multimeter? Gradually adjust the frequency 10, 50, 200, 1k, 10k, 25k, 100k, 500kHz and 1MHz. What is measured by the multimeter? Try to explain the multimeter behavior.

6) Set the generator for rectangular pulses of 100 Hz repeating frequency and pulse width of 100 μs. Set the low voltage level to 0V. The high level (pulse amplitude) set gradually to 0.02V, 0.2V, 2V. How does the measured rms value change for different peak values of the signal? What voltage value is shown by the multimeter? Is its variation consistent with the changes of the pulse amplitude? Compare your measurement results acquired with other types of multimeters.

7) Repeat task 4 for AC and DC current through the load. How can you calculate total power dissipated on the resistor load from the measured current and resistor's value? Compare results with those of the task 4.

8) Test available diodes using a multimeter and assess whether they passed. What does this measurement tell us about the measured diode? Measure also the Graetz bridge

9) Measure PN junctions and h21E of available transistors in the active and inverse mode. Compare measured results with datasheet values.

10) Switch the multimeter to frequency measurement mode. Set the generator to an arbitrary harmonic waveform of frequency within kHz range. Gradually rise the amplitude from minimum up to 5V. Observe the measured frequency and determine an amplitude threshold, where multimeter starts to measure correctly. Try to explain the results and behavior of the multimerter in frequency measurement mode.

Instruments' manuals:

Multimeter UT 803

Multimeter Agilent 34410A

Multimeter Agilent 34405A

Multimeter Metex 3640

Multimeter METEX 3850D

Generator Agilent 33220A

Study materials:

Agilent multimeter simulation installation files

Website simulating the function of selected instruments - meas-lab.fei.tuke.sk